A Study on Physicochemical

Properties, Nutrient Analysis, Antioxidant Efficacy and Product Development of Mango Seed Kernel varieties (Powder and Oil) of Karnataka

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SYNOPSIS

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Introduction:

Mango (Mangifera indica) is the king of the fruit and is popular worldwide due to its exotic flavor and delicious taste. Around 20 % of mango is processed for products such as puree, nectar, leather, canned slice and chutney, juices, fruit bars, and pies. During the processing of ripe mango, its peel, and seed are generated as a waste, which is approximately 40-50 % of the total fruit weight [1]. The mango seed represents about 20 % of the total weight of fruit, while the kernel is 45-75 % of the seed [14].

As reviewed by [3] mango kernel is rich in minerals like iron, potassium, calcium and zinc along with phytosterols. Mango kernel powder (MKP) is a rich source of ascorbic acid, carotenoid, polyphenol, and also exhibits good anti-oxidant property. Mango seed kernel also possesses anti-microbial activity, which shows its potentiality as a natural antibiotic and antifungal [4]. Some research has been carried out to partially substitute wheat flour by MKP for the formulation of cookies, biscuits, and bread [6] [1].

Many researchers have reviewed the nutritional, phytochemicals, and functional properties of MKP. [5] Found that mango seed kernel of Egyptian varieties is rich in all eight essential amino acids. [6] Found that drying methods affect the polyphenol, anti-oxidant activity, and functional properties of MKP.

[7] Reviewed that mango kernel oil does not contain trans-fatty acid, and carry the great potentiality for the food industry.MKO has been tested to be resistant to auto oxidation owing to a high content of saturated fatty acids; therefore, it can be stored for an extended period without affecting its physicochemical and functional properties. For these reasons, MKO improves the stability and shelf life of highly oxidative oils when mixed with [8].

Mango varieties of State Karnataka are Raspuri, Totapuri, Alphonso, Badami, Banganpalli, Dashehari, Kesar, Neelum, Mallika, Malgoa, Amrapali and Sindura.

Certain researches have been done on physicochemical properties of mango kernel oil, which focuses on the acid, peroxide, iodine & Saponification values of MKO. The **Acid Value** acts as the primary criterion for determining the edibility of oils. It measures the extent to which glycerides are hydrolyzed are decomposed by light, heat, and lipase enzyme present in the oil. Lipase enzyme originates from the tissues of oil-bearing material, including microorganisms [11]. The recommended range of acid value for edible oil is a maximum of 10 mg KOH/g for virgin palm oils, 4 mg KOH/g for cold-pressed and virgin oils, and 0.6 mg KOH/g for refined

oils [10]. MKO has an **acid value** lower than the maximum recommended for virgin oils that is from (3.23 – 5.35) and therefore, is acceptable for food applications [9].

The **Peroxide value** expresses the degree to which the oil can be oxidized to develop rancidity. High peroxide value indicates high rates of rancidity. Oxidative rancidity refers to the addition of oxygen across the double bonds of unsaturated fatty acids, which takes place due to the presence of enzymes or certain chemical compounds. Peroxide value for edible vegetable oils has a recommended maximum of 15 mEq O2/kg for cold-pressed and virgin oils, and 10 meq O2/kg for refined oils [10]. MKO has a low peroxide value (< 10), which is the major attributing factor for its oxidative stability [11].

The **Iodine value** measures the degree of hardness and unsaturation of oils or fat. A lower value indicates that the oil is more saturated, while a high value signifies highly unsaturated oil. Iodine value is analogous to peroxide value and serves as an index for evaluating the susceptibility of oil to rancidity. Highly saturated oils (low iodine value) are less prone to oxidative deterioration and can be stored for an extended period when compared to highly unsaturated fats [11]. Codex recommends an iodine value of 75 to 94 g I2/100 g for virgin and refined olive oil. However, the iodine value of MKO is highly variable depending on the mango variety and the method of oil extraction [9].

The **Saponification value** measures the average molecular weight of all fatty acids present in fats and oils, and the value increases with a decrease in molecular weight. A Saponification value represents the amount (in mg) of KOH required to saponify 1 g of oil/fat. It indicates the size and nature of FFA present in the oil. The higher the value, the more soluble is the soap manufactured from it [13]. Codex recommends a Saponification value of 184 to 196 mg KOH/g for both virgin and refined olive oil. According to [12], the Saponification value of MKO is high (187 to 195 mg KOH/g) and compares well with that of flax seed, hemp seed, apricot kernel, corn oil, Shea butter, and cocoa butter.

The concept of healthy ingredient has raised the interest in the use of flour with an ample number of phytochemicals. Despite high nutritional and health benefits, mango kernel is a major byproduct of the mango processing industry and commercial exploration is negligible [5]. So, this research attempts to highlight the Physicochemical Properties, Nutrient Analysis, Antioxidant Efficacy and Product Development of available varieties of Mango Seed Kernel Powder and Oil.

Objective:

1. To study the physicochemical properties of available varieties of Mango kernel Powder (MKP) & Mango kernel Oil (MKO)
2. To study Nutrient Analysis of available varieties of MKP
3. To study fatty acid composition of available varieties of MKP (PUFA & MUFA)
4. To study selected Antioxidant Properties of available varieties of MKP
5. To Develop Standardized Products by Incorporating MKP of available varieties and Sensory Evaluation

Review of Literature:

Title	Author	Result	Year
Mango seed kernel oil and its physicochemical properties	Kittiphoom, S. and Sutasinee, S.	Mango seed kernel oil was extracted using soxhlet extraction with petroleum ether, ethanol and hexane. The physicochemical properties (acid value, iodine value, peroxide value and saponification value), the fatty acid composition and phenolic contents, of mango seed kernel oil were examined. Oil extracted with hexane has better overall quality. Its acid, peroxide, iodine saponification values and phenolic content were 0.10 mg KOH/g oil, 8.72 mg/g oil, 38.50 mg/100 g oil, 207.5 mg KOH/g oil and 98.7 mg/g, respectively. The main fatty acids found in the mango seed kernel oil were steric acid and oleic acid. The results suggested that mango seed kernel oil is a good source of the unsaturated fatty acid, phenolic compounds and has the potential to be used as nutrient rich food oil or as ingredients for functional or enriched foods.	**2013**
Comparison of the physico-chemical and functional properties of mango kernel flour with wheat flour and development of mango kernel flour based composite cakes	Pabitra, Chandra Das. Md,Junaeid, Khanb. Md,Sharifur, Rahman , Sumana, Majumderd and Md. Nazrul, Islam.	The aims of this study were to process mango kernel flour (MKF) and to compare its nutritional, functional and physical properties with WF and finally to evaluate the quality of MKF substituted composite cakes. Analysis showed that MKF contained comparatively higher energy than WF (4.12 vs 3.54 kcal/ g), while proximate compositions were: 7.58% moisture, 2.16% ash, 8.03% protein, 10.16% fat, 1.16% crude fiber and 72.07% total carbohydrate in MKF. Bulk density and water absorption capacity of MKF was higher than WF, while oil absorption capacity, swelling index and brightness were higher for WF. Most of the macro nutritional components of the developed cakes increased with increasing of MKF content and around 3.60% more energy was given by 40% MKF containing cake	2019

		compared to control one.	
Evaluation of Physicochemical Properties of Iranian Mango Seed Kernel Oil	Maryam,Fahimdaneshand Mohammad,ErfanBahrami	During processing of mango, by-products such as peel and kernel are generated. In his stud the oil of mango seed kernel was extracted using Soxhlet apparatus and fatty acid composition shows that mango seed kernel oil consist of about 44–48% saturated fatty acids and 52–56% unsaturated. Stearic acid (37.73%) was the main saturated fatty acid,while oleic acid(46.22%) was the major unsaturated fatty acid in mango seed kernel oil. The specific gravity(0.9 at 40 , refractive index(1.443 at 40 , peroxide value(1.2 meq/kg), unsaponifitable matter (2.9%),free fatty acid(1.5%),saponification number(195) ,iodine number(55),melting point(30 , and total lavibondcolour(25) for mango seed kernel oil was determined. Result shows that mango seed kernel oil is more stable than many other vegetable oils rich in unsaturated fatty acids. Such oils seem to be suitable for blending with vegetable oils, stearin manufacturing, confectionery industry or/and in the soap industry.	2013
Optimization and extraction of oil from mango seed kernel (Mangifera indica)	Kaushlesh, k, yadav. Neelima, garg. Anil, verma. Sanjay, kumar and mala, trivedi5	Kernels from the stone of mango (Mangifera indica L.) were separated from outer leather by decortications and dried to evaluate the oil content. Conditions were optimized for oil extraction from mango seed kernel. The influence of various parameters such as temperature, time, volume of n-hexane (solvent) and particle size on oil yield was investigated. The results revealed that oil yield increased with increase in temperature, time and volume of solvent but decreased with the increase in the particle size. Maximum oil yield of 15.20% was obtained at 1 mm size grinded kernel particles with an extraction time of 90 minutes using 25g of mango kernel seed and 250 mL of n-hexane. The proximate composition and characteristics including the un-saponification matter and fatty acid contents of kernel oil were determined. The major fatty acids present in mango kernel were stearic (58.08%), palmitic acid (1.33%) and oleic (17.99%) and linoleic (2.86%). Mango seed kernel oil contained high un-saponifiable matter which could have good potential to be used in cosmetics.	2017
Physicochemical characteristics, bioactive compounds and industrial applications of mango	Peter, Waboi ,Mwaurah., Sunil, Kumar., Nitin, Kumar., Anil, Panghal., Arun, Kumar, Attkan., Vijay, Kumar, Singh and Mukesh, Kumar, Garg.,	In this research they have used four mango varieties [Kibangou (Nigeria), Zebda (Egypt), Kesar (India), Apple, Ngowe, Kent, and Sabine (Kenya)]and analyzed for the nutritional composition of mango kernel which shows the values as 32.34% to 76.81%	2020

kernel and its products: A review		carbohydrate, 6% to 15.2% fat, 6.36% to 10.02% protein, 0.26% to 4.69% crude fiber, and 1.46% to 3.71% ash on a dry weight basis. They also studied the antioxidant capacity of mango kernel powder using four different assays, hence the antioxidant capacity was the highest (1,819 µmol Trolox equivalent (TE)/g db) in ORAC assay followed by DPPH (1,799.54 µmol TE/g db), ABTS (1,724.09 µmol TE/g db), and FRAP assay (942 µmol TE/g db).	
Physico chemical characteristics of mango kernel oil and meal	Sahar, A,Abdelaziz.,	In the present study the Physico chemical characteristics of mango kernel and its oil were studied which gives the results as the proximate compositions of whole kernel on dry bases were 6.05%, 7.53%, 11.00%, 2.77%, 2.45% and 69.20% moisture, Crude protein, Crude fats, Total ash, Crude fiber and Total carbohydrates respectively. While, Potassium, magnesium, Sodium, Calcium, iron, zinc and Copper were 310, 230, 2.65, 185, 9.30, 6.10 and 4.20 mg/100g on dry weight basis respectively. The characteristics of mango kernel oil the Specific gravity at 24° C, Reflective Index and Iodine value (g/100g oil) were 0.89, 1.58 and 46.0, respectively. Whereas, the value of free fatty acid, Saponification value and Peroxide value were 3.97, 192 and 1.73 respectively. The major fatty acids of the triacylglycrolwas oleic acid (44.89%) followed by Stearic acid (36.57%) shown.	2018
Study of Nutritiona.0l, Phytochemicals and Functional Properties of Mango Kernel	Pravin, ojha., shreejana, raut., ujjwol, subedi., and nawaraj,upadhaya.,	This research was conducted to study the effect of different treatments, namely soaking and blanching, on nutrient, phytochemical, and functional properties of mango kernel powder (MKP). Three treatments were carried out to produce MKP, which were soaking (48 h), heat treatment/blanching (45 °C for 2 min), and control. The seed was cut into four pieces and dried in cabinet drier for 7 h at 60 °C until it becomes brittle. The kernel was ground to pass through a 0.85 mm size sieve. Powder from three treatments was subjected to nutrient analysis, phytochemical analysis, and functional properties evaluation. Crude fat increased significantly (p	2019
Characterisation of Mango Kernel Fat and Preparation of Tran's-Free Margarine for Use in Muffins	Jeyarani ., Suraj , Subramanian., Sneha,R., Sudha and Negi, P,S.,	Six different samples of mangoes were found to contain 13.0-15.3% seeds and 41.1-66.7% kernels. The seed kernels contained 9.6-10.6% fat with slip melting point ranging from 24°C-30°C. Gas chromatographic analysis showed that the major fatty acids were stearic acid (31.3-41.3%), oleic acid (38.7- 42.3%) and palmitic acid (8.3- 11.3%). Mango kernel fat was blended with palm oil at 0 to 30% levels	2015

		and margarines were prepared incorporating suitable additives. Margarine containing 30% palm oil blend (experimental margarine-EM) showed textural characteristics closer to commercial bakery margarine (CM). Muffins were prepared by replacing CM with EM at 25, 50, 75 and 100% levels. Fat content of the muffins ranged between 24.8 and 26.2%. Fatty acid composition showed a decrease in palmitic acid and trans fat acid and increase in stearic acid content. Physical characteristics and sensory evaluation showed that muffins prepared by replacing 50% of CM were highly acceptable. Thus, it could be concluded that muffins having improved fatty acid profile can be prepared utilizing mango kernel fat.	
Use of Mango Seed Kernels for the Development of Antioxidant Rich Biscuits	Amritpal, Kaur and Jaswinder, Kaur, Brar.,	The purpose of the study was proper utilization of mango seed kernels. Mango seed kernels were processed and flour was prepared for the development of antioxidant rich biscuits. One control and four experimental samples were prepared by incorporating 10-40 percent level of mango seed kernel flour and evaluated for their sensory attributes. Control and acceptable experimental sample were analysed for their nutritional composition. Incorporation of mango seed kernel flour in biscuits at 30 percent level was organoleptically acceptable. The energy, crude fat, crude fiber and total ash content of developed biscuits were significantly higher ($p<0.01$) as compare to control samples. A significant increase ($p<0.01$) in minerals such as calcium, iron and magnesium content of developed biscuits was found. Antioxidant activity was found to be significantly higher ($p<0.01$) in mango seed kernel flour supplemented biscuits and percent increase in antioxidant activity was 23 per cent. Hence, the use of mango seed kernel flour can play an important role in improving nutritional value of diets.	2018
Use of mango seed kernels for the development of antioxidant rich idli and mathi	Amritpal Kaur	The purpose of the study was proper utilization of mango seed kernels. For this purpose, mango seeds were collected, washed, mango seed kernels separated, blanched for 2 minutes, dried at 60° C for 6 hours and ground into flour. Two products namely mathi and idli were prepared by incorporating 10-40 per cent level of mango seed kernel flour and evaluated for their sensory attributes. Control and acceptable experimental samples were analysed for their nutritional composition. Incorporation of mango seed kernel flour at 10	2017

		per cent level was organoleptically acceptable. The energy, crude fat, crude fiber and total ash content of supplemented products were significantly higher ($p<0.01$) as compare to control samples. A significant increase ($p<0.01$) in mineral content of developed products namely calcium, magnesium and iron content was found. Antioxidant activity was found to be significantly higher ($p<0.01$) with mango seed kernel flour supplementation in mathi and idli. Hence, the use of mango seed kernel flour can play important role in improving nutritional composition of diets.	

Methodology:

1. **To study the physicochemical properties of available varieties of Mango kernel Powder (MKP) & Mango kernel Oil (MKO)**
   i) Physical Propertiesof available varieties of Mango kernel:

      a) Total weight of the fresh and dried Mango kernel
      b) Length of the fresh and dried Mango kernel
      c) Width of the fresh and dried Mango kernel
      d) Density of the fresh and dried Mango kernel

   ii) Chemical propertiesof available varieties of Mango kernel Oil:

      a) Iodine Value estimation by AOAC 993.20
      b) Saponification Value by AOCS Cd 3-25 (03)
      c) Acid Value by AOCS Cd 3d-63 (03)
      d) Peroxide Value by AOCS Cd 8b-90

2. **To study Nutrient Analysis of available varieties of MKP**

   i) Proximate Composition:
      a) Estimation of Ash using Anon Method (Anon, 2000).
      b) Estimation of moisture using Anon Method (Anon, 2000).
      c) Estimation of Total Lipids using AOAC method
      d) Estimation of protein using estimated by Kjeldhal plus method using Pelican Kel plus equipment (Anon., 2000).
      e) Estimation of carbohydrates using (Ranganna 1986)

   ii) Minerals
      a) Estimation Iron by wet digestion using triacid mixture (Anon., 2000).
      b) Estimation of calcium titrimetric method(Ranganna, 1986)

c) Estimation of zinc by calorimetric method. (Ranganna, 1986)

iii) Vitamins:

a) Vitamin-A by AOAC 974.29
b) Vitamin- E by AOAC 971.30
c) Vitamin- B_{12} by AOAC 952.20

3. To study fatty acid composition of available varieties of MKP (PUFA & MUFA)

The Estimation of Polyunsaturated Fatty Acids (PUFA) and Monounsaturated Fatty Acids MUFA by Gas Chromatography method.

4. To study selected Antioxidant Properties of available varieties of MKP

i) Estimation of total phenolic was determined by the spectrophotometer method (Singleton V.L., Rossi J.J.A., 1965)

ii) Estimation of Flavonoids using the method given by Chang.C.,Yang.M., Wen H. and Chern, J.2002

iii) Estimation of Total antioxidant capacity using spectrophotometric method as mentioned by Shirwaikar*et al*., (2003).

5. To Develop Standardized Products by Incorporating MKP of available varieties and Sensory Evaluation

The products to prepare from Mango kernel are biscuits, chakali, mukhwas, Achar, payasam, appam, coffee, Halwa, curry and papad.

Sensory evaluation of these products carried out using 9-point Hedonic scale with scores 9-like extremely & 1- dislike extremely.

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